Harlequin Duck Population Dynamics in Prince William Sound: Measuring Recovery

2008 Progress Report (Project: 080759)

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Alaska Department of Fish and Game
September 2008

In March 2008 we completed the 8th year of monitoring surveys since the inception of winter surveys in 1997. These surveys measure recovery of harlequin ducks by comparing changes in demographic parameters within and between oiled and unoiled sites in Prince William Sound. Surveys were expanded in 2007 to compare the potential disparity of harlequin duck densities between oiled and unoiled regions over time and better estimate the number of ducks we would expect to observe in oiled areas. The surveys were expanded again in 2008 to collect data to address the need for estimates of within-year transect variability and determine how effectively we can analyze data at smaller spatial scales.

In addition to completing surveys to compare density and population age and sex structure between oiled and unoiled areas of PWS, we resurveyed 20 oiled and 20 unoiled transects originally surveyed in March of 1972 and 1973. These 1972 and 1973 surveys are the only prespill winter data available on population abundance and we now have two years of post-spill data for comparison with the pre-spill data.

We have begun preliminary analytical work to 1) compare changes in density between treatments (oiled and unoiled survey areas) and population structure (immature males, adult males, and females) from 1997 through 2008; 2) compare annual changes in density and population structure *within* oiled and unoiled treatments and 3) Compare changes in densities of harlequin ducks from winter surveys of 1972 and 1973 with winter surveys from 2007 and 2008 (based on oiling history).

In April 2008 we began a pilot study to 1) develop a sampling protocol to improve estimates of within year transect variability for oiled and unoiled treatments; 2) determine the spatial scales suitable for trend and composition estimates relevant to oil history; and 3) develop a new survey protocol to improve our ability to estimate changes in the number of harlequin ducks at smaller spatial scales. We completed from 3-5 replicate surveys for 5 transects in oiled areas of WPWS and on Montague Island. We need to continue with this effort in 2009 before we can complete our objectives.

All data has been entered and we have conducted quality control review and are beginning preliminary analysis.

Preliminary evaluation of survey data does not does not indicate any marked differences from prior year values for changes in densities or population structure for oiled or unoiled areas.

From cursory review, our data indicates a low likelihood that populations have behaved differently in oiled and unoiled areas since 1972-1973 and it also indicates that populations have likely been stable or increasing slightly for both oiled and unoiled areas since 1972-1973. Much more in-depth analysis still needs to be conducted.

With the above survey obligations and the potential for pre-migratory movements of harlequin ducks in late-spring, we had a narrow window in which to conduct replicate surveys. This required us to conduct the replicate surveys in early to mid-April. Poor weather reduced this window. Primarily on Montague Island, movements of harlequin ducks, presumably related to pre-herring spawn activity, forced us to discard some replicate surveys. These will have to be repeated in 2009 at an earlier date.

We are continuing to analyze data and designing the 2009 survey protocols to allow us to complete the replicate sampling.

PROPOSAL SIGNATURE FORM

THIS FORM MUST BE SIGNED BY THE PROPOSED PRINCIPAL INVESTIGATOR AND SUBMITTED ALONG WITH THE PROPOSAL. If the proposal has more than one investigator, this form must be signed by at least one of the investigators, and that investigator will ensure that Trustee Council requirements are followed. Proposals will not be reviewed until this signed form is received by the Trustee Council Office.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council Data Policy**, adopted July 9, 2002) and reporting requirements *(Procedures for the Preparation and Distribution of Reports***, adopted June 27, 2007).

PROJECT TITLE: Harlequin Duck Population Dynamics in Prince William Sound: Measuring Recovery from the *Exxon Valdez* Oil Spill

Printed Name of PI: Dan Rosenberg

Signature of PI: _____ Date 9/4/08

Printed Name of co-PI: NA

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Printed Name of co-PI: NA

Signature of co-PI: _____ Date _____

* Available at www.evostc.state.ak.us/Policies/data.htm
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PROPOSAL SUMMARY PAGE
(To be filled in by proposer)

Title: Harlequin Duck Population Dynamics in Prince William Sound: Measuring Recovery from the *Exxon Valdez* Oil Spill

Project Period: October 1, 2008 – September 30, 2009

Proposer(s): Dan Rosenberg, Alaska Dept. Fish and Game
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Study Location: Prince William Sound

Abstract: Since demographic studies were initiated, Cytochrome P450 1A induction studies have documented exposure to EVO at smaller spatial scales than population monitoring studies can measure. This biomarker of oil exposure has been correlated with lower female survival and is consistent with a lower proportion of females in oiled areas. However, broad scale demographic studies indicate population stability in oiled areas and not the decline expected if oil exposure reduces survival rates. This proposal attempts to continue demographic studies and improve their ability to assess data at smaller spatial scales commensurate with extant oil exposure, lingering oil, and oiling intensity. We will assess the range of variability on our transect counts and if successful in reducing the spatial scales for data analysis we will develop and implement a new survey protocol that can incorporate our historical winter data (1997–2008) while improving our ability to detect changes in abundance and composition at smaller spatial scales.

Funding:

	FY09
EVOS Funding Requested:	$182.1
(must include 9%GA)	$16.4
TOTAL:	$198.5
Non-EVOS Funds to be Used:	$10.0
TOTAL:	$208.5

Date: September 4, 2008

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Harlequin Duck Population Dynamics in Prince William Sound: Measuring Recovery from the *Exxon Valdez* Oil Spill

Exxon Valdez Oil Spill Trustee Council
FY 2008-2009 Proposal (Interim Funding Request)
Injured Resources and Services

I. NEED FOR THE PROJECT

A. Statement of Problem

Harlequin duck (*Histrionicus histrionicus*) populations in Prince William Sound (PWS) have not fully recovered from the effects of 1989 *Exxon Valdez* Oil Spill (EVOS Trustee Council 2002, Integral Consulting Inc. 2006). The outlook for full recovery for harlequin ducks is improving (Rosenberg et al. 2006, Integral Consulting Inc. 2006). However, bioavailable oil remains in the intertidal (Short et al. 2004, Short et al. 2005) and ducks residing in intertidal habitats are still being exposed to this lingering oil (Ballachey et al. 2006). The lack of a population increase (Rosenberg et al. 2005, McKnight et al. 2006) and the lower proportions of females in oiled areas (Rosenberg et al. 2005) coupled with chronic exposure (Ballachey et al. 2006) and lower female survival through 1998 (Esler et al. 2000a) suggest that oil exposure and population dynamics are linked and may be inhibiting full recovery.

The current status of harlequin duck populations in oiled areas of PWS is a result of the initial impacts from the spill, continued exposure to lingering oil, and other environmental stressors. Harlequin ducks occur year-round in intertidal zones of PWS (Isleib and Kessel 1973). At least 1,298 harlequin ducks (approximately 7% of the wintering population in PWS but a much higher percentage of ducks within oiled areas) were estimated to have died as a direct result of oil exposure following the *Exxon Valdez* oil spill (J. Piatt pers. comm.). Much of the *Exxon Valdez* oil was deposited in nearshore habitats where harlequin ducks reside (Galt et al 1991). The persistence of this oil (Short et al. 2004) created the potential for long-term chronic effects from continued exposure which was additive to the initial acute mortality that occurred immediately after the spill (Trust et al. 2000, Peterson 2001, Esler et al. 2002, Rosenberg et al. 2005, Ballachey et al. 2006).

Population recovery for harlequin ducks has taken much longer than anticipated at the time of the spill. Harlequin ducks are relatively long-lived birds with delayed sexual maturity and low rates of annual recruitment and dispersal. Long-term population stability depends on high adult survival coupled with a few years of successful reproduction. Population levels may change slowly. In addition, harlequin ducks are highly philopatric to breeding, molting, and wintering sites (Robertson and Goudie 1999, Robertson et al. 2000). This is an adaptive strategy in natural situations and predictable environments. It is not favorable in the face of dramatic environmental perturbations and does not favor rapid recovery or colonization of new sites. Initial high losses of adults, especially females, coupled with many years of chronic oil exposure may result in a long recovery period. Once oil exposure abates full recovery may still take many years.

Population monitoring provides the most direct approach to assess recovery because it measures changes in abundance and composition. Harlequin duck population surveys in PWS following the spill were designed to measure recovery based on the EVOS Trustee Council Recovery Objectives for harlequin ducks. Although recovery objectives have been modified over the years, the most recent iteration states that "Harlequin ducks will have recovered when breeding- and nonbreeding season demographics return to prespill levels and when biochemical indicators of hydrocarbon exposure in harlequins in oiled areas of Prince William Sound are similar to those in harlequins in unoiled areas (EVOS Trustee Council 2006).

Unfortunately, pre-spill data on harlequin duck population trends and demographics in PWS are limited, making it difficult to compare post-spill trends with pre-spill data. Thus, most of the demographic information available for evaluating the status of injury comes from post-spill comparisons of oiled and unoiled areas of PWS (Rosenberg and Petrula 1998, Lance et al. 2001, Rosenberg et al. 2005, McKnight et al. 2006).

These demographic studies have been designed to compare population level effects at spill-wide and smaller but still broad regional spatial scales (Rosenberg et al. 2005) but were not intended to assess demographic changes based on oiling history at much smaller spatial scales (i.e. individual shoreline segments or bays). Since demographic studies were initiated, Cytochrome P450 1A induction studies have documented exposure to EVO at these much smaller spatial scales (Esler et al. 2000, Ballachey et al. 2006). This biomarker of oil exposure has been correlated with lower female survival (Esler et al. 2000a) and is consistent with demographic studies that have identified a lower proportion of females in oiled areas (Rosenberg et al. 2005). However, broad scale demographic studies (Rosenberg et al. 2005, McKnight et al. 2006) indicate population stability in oiled areas and not the decline in abundance expected if continued oil exposure reduces survival rates significantly or conversely the increase in abundance expected if exposure rates are declining.

This has generated interest in improving the ability of demographic studies to assess data at the smaller spatial scales commensurate with extant oil exposure and oil history. Differing population trends and composition for areas with continued exposure may be masked when analyzing data at much broader spatial scales within the spill area. Confounding this is the length of time since the spill, making it increasingly difficult to separate continued oil effects form natural or anthropogenic factors that may affect population structure or growth rates.

ADF&G demographic studies (Rosenberg and Petrula 1998, Rosenberg et al. 2005) were designed so they could be analyzed in a hierarchal fashion at different spatial scales or by degree of oiling but are limited by the variability in counts for individual transects. This is due to the mobility of harlequin ducks and their patchy distribution within PWS. Thus, before we can compare population level effects at much smaller geographic scales we need to assess whether we can improve our power to detect differences in trends at these smaller scales by reducing sampling variability for individual transects.

We propose to continue a pilot study initiated in FY08 to complete the assessment of variability on transect counts. If the Pilot Study allows us to reduce the geographical spatial scale for data analysis we will develop and implement a new survey protocol that incorporates our historical

winter data (1997–2008) while improving our ability to detect changes in abundance and composition at these smaller spatial scales.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The demographic parameters we are measuring are consistent with EVOS Trustee Council recovery objectives. This study directly assesses the recovery status of harlequin ducks in PWS and is directly linked to the recovery goals, objectives and restoration strategy for harlequin ducks in the EVOS Restoration Plan including estimates of population sizes and trajectories in the spill area and comparisons of population estimates in oiled and unoiled areas of PWS (*Exxon Valdez* Oil Spill Trustee Council 2002). Additionally, continued demographic monitoring of harlequin ducks was recommended by Integral Consulting Inc. (2006).

Two main hypotheses have been presented to explain lack of full recovery: (1) ingested oil or contaminated prey is continuing to cause higher mortality rates and/or (2) initial mortality caused significant losses to the western PWS population, which may result in a protracted recovery period. This project will help assess the recovery rate and identify constraints to recovery of harlequin ducks by providing winter population trends, comparing population structure, and providing an index of recruitment between oiled and unoiled areas. It will also provide insight into geographic differences within PWS. In the short-term it will help us understand the effects of exposure to lingering oil and in the long-term help identify mechanisms of population change in the nearshore environment.

Information from this project will incorporated into a population model that will improve our ability to predict rates of population change and estimate the time period necessary for full recovery (EVOS Project 070816, Evaluating Harlequin Duck Population Recovery: CYP1A Monitoring and a Demographic Population Model). There are no precedents for recovery from oil spills for harlequin ducks. Harlequin duck populations have relatively low intrinsic growth rates (Goudie et al. 1994) so full recovery from initial and chronic mortality may be delayed until long after all spill effects have abated (Esler et al. 2002). While some of the demographic information for a model has been collected for PWS populations (Rosenberg and Petrula 1998, Rosenberg et al. 2005, Holland-Bartels et al.1999) and harlequin ducks in North America (Goudie et al. 1994, Robertson and Goudie 1999), long-term data on natural variation, productivity, recruitment, dispersal, and immature survival are still lacking.

Long-term data sets are needed for predictive modeling of ecological change. Harlequin ducks occur year-round in the nearshore environment, feed on benthic invertebrates, exhibit site-fidelity, are relatively long-lived, and are widely dispersed in the Gulf of Alaska. They are the only benthic feeding avian species present in abundance year-round in PWS. These characteristics make them unique among nearshore avian predators and ideal candidates for monitoring ecosystem change.

In addition to establishing population recovery from the EVOS, identifying and establishing mechanisms of population change depends on an historical knowledge of the status of the resource prior to environmental perturbations and an understanding of the inter-annual variability among years in periods of relatively little perturbations in the larger physical system. Thus, our ability to

detect departures from natural variation is necessary if we are to accurately evaluate the effects of major environmental perturbations whether natural or human-caused. This requires numerous samples, distributed through space and time. We are focusing on relatively long-lived avian predators that tend to show less natural variability. With time-series data on harlequin duck abundance and distribution in concert with abiotic and biotic ecosystem changes we will improve our ability to interpret the affects of natural or man-induced processes and understand the mechanisms of population change.

Results of this work will have a direct bearing on assessing the status and outlook for this resource and help guide agency programs and policies related to public uses, including subsistence and recreational hunting, land-use practices, and wildlife viewing.

II. PROJECT DESIGN

This study will attempt to improve our assessment of the recovery status of harlequin ducks in oiled areas of PWS by comparing changes in abundance (densities) and structure (sex and age ratios) between oiled and unoiled areas (treatments) since 1997 at smaller spatial scales than previously analyzed. We will complete a pilot study begin in FY08, to assess the variability on our transect counts. If variability allows we will develop and implement a new survey protocol that will incorporate our historical winter data (1997–2008) but improve our ability to detect changes in abundance and composition at smaller spatial scales commensurate with areas of extant oil exposure in harlequin ducks (Cytochrome P450 1A induction) and oiling history.

Planning is complicated by the desire to expedite the project. Prior EVOS Restoration Office commitments will not allow us to complete the Pilot Study in FY08. This necessitates continuing the Pilot Study in FY09. We will then analyze the data and develop new survey protocols in time to conduct the Population Monitoring survey in March 2009 using these new protocols.

Pilot Study

The pilot data will give us estimates of within-year transect variability. Depending on the magnitude of transect variability we will create smaller “sub-regions” (i.e. consolidating several transects) which will be associated with oiling intensities (high, medium, low). The number of transects composing a sub-region will depend on variability.

A. Objectives

1. Develop a sampling protocol to improve estimates of within year transect variability for oiled and unoiled treatments;

2. Determine the spatial scales suitable for trend and composition estimates relevant to oil history; and

3. Develop a new survey protocol to estimate changes in number of harlequin ducks and sex and age composition at smaller spatial scales.

No hypothesis is being tested.

Population Monitoring Surveys

If the pilot study succeeds in allowing us to reduce the geographic scale for data analysis we will develop and implement a new survey protocol that will improve our ability to detect changes in abundance and composition at smaller spatial scales while maintaining our historic winter data (1997–2008) in the model. For now our objectives remain the same as our previous surveys (Rosenberg et al. 2005) as we will not modify them to reflect changes in structure or density at smaller spatial scales until we know the results of the pilot study. If the new survey protocol requires additional sampling intensity we may eliminate Objective 4 (below) from the proposed March 2009 surveys.

A. Objectives

1. Compare population structure (immature males, adult males, and females) between treatments (oiled and unoiled survey areas) from 1997 to present.

2. Compare annual changes in density between oiled and unoiled treatments from 1997 to present.

3. Compare annual changes in density and population structure *within* oiled and unoiled treatments.

4. Compare changes in densities of harlequin ducks between winters of 1972 and 1973 with winter surveys for both oiled and unoiled areas.

5. Add to our knowledge of harlequin duck life history and provide long-term data set for population modeling.

6. Monitor numbers of Barrow's and common goldeneyes, surf, white-winged, and black scoters, red-breasted and common mergansers, and loons within the study area.

7. Integrate data with other long-term monitoring surveys to detect long-term changes in marine ecosystems

This study will test the following hypotheses:

1. Objective 1.
   H_o: The ratio of males to females; total ducks to subadult males; and breeding pairs to total ducks is the same for oiled and unoiled populations during March.

   $H_{1:}$ The ratio of males to females; total ducks to immature males; and breeding pairs to total ducks is different for oiled and unoiled populations during March.

2. Objective 2.

Ho: The rate and direction of population change between years is the same for oiled and unoiled survey sites.

$H_{1:}$ The rate and direction of population change between years is different for oiled and unoiled survey sites.

3. Objective 3.
H_o: The rate and direction of population change between years is the same within oiled and unoiled survey sites.

H_1: The rate and direction of population change between years is different within oiled and unoiled survey sites.

4. Objective 4.
To compare the potential disparity of harlequin duck densities between oiled and unoiled regions over time (1972-1973 data with our data) we will examine the ratio of average density in the following hypothesis:

H_o: No difference in density ratio exists between historical counts and contemporary resampling on the same transects.

$$\frac{\text{density}_{\text{oiled}}}{\text{density}_{\text{unoiled}}}$$

H_1: There is a difference in the density ratio between historical counts and contemporary resampling on the same transects.

5. Objective 5. No hypothesis is being tested.

6. Objective 6. No hypothesis is being tested at this time.

7. Objective 7. No hypothesis is being tested at this time.

B. Procedural and Scientific Methods

Pilot Study

The Pilot Study initiated in April 2008 will be continued in winter 2009. Once completed, we will quickly analyze data and design new protocols prior to March 2009. Surveys cannot be conducted from mid-April to mid-November due to seasonal movements of birds.

Transects will be selected from both oiled and unoiled areas. Logistical constraints require transects be relatively close geographically if possible, with care taken to choose transects of varying characteristics to reduce potential bias. In oiled areas we will include transects where ducks have been documented to exhibit oil exposure. The selected transects will be surveyed

repeatedly (we estimate five replicates each depending upon variability) at varying conditions (weather, tides, time of day). General survey methods will follow procedures in Rosenberg et al. (2005).

If possible we will incorporate transects from the USFWS Marine Bird Surveys (McKnight et al. 2006) into our analysis to increase the number of transects in the oiled area. We will also attempt to incorporate estimates of measurement variability from sampling conducted by the Nearshore Vertebrate Predator Project (Esler et al. 2000b). Our initial scaling efforts will focus on those areas where oil exposure (Cytochrome P450 1A induction) in harlequin ducks was identified (Trust et al. 2000, Ballachey et al 2006).

Population Monitoring Surveys

We propose to continue winter boat surveys with the new protocols if the pilot study succeeds in meeting our objectives. If so, transects will be selected from those surveyed in project 407 (Rosenberg et al. 2005). If not, we can continue with our original survey design which will increase statistical power to detect recovery, improve our ability to assess changes in the marine ecosystem, and quantify geographic variation within PWS. Surveys will be conducted in late-winter and follow procedures and methods in Rosenberg et al. 2005. For harlequin ducks, observations will be recorded by sex and males will be divided into two age groups using predetermined criteria (Rosenberg and Petrula 1998).

To compare the potential disparity of harlequin duck densities between oiled and unoiled regions over time we will examine the ratio of average density between historical counts conducted in March of 1972 and 1973 (Dwyer et al. 1976, reanalyzed by Klosewski and Laing 1994) and contemporary resampling of the same transects. Although the recovery goals and objectives for harlequin ducks include a return to conditions had the spill not occurred and a return to prespill population demographics (Exxon Valdez Oil Spill Trustee Council 2002), little historical demographic data exists for comparison. Surveys conducted in 1972 and 1973 are the only prespill winter data available on population abundance. In the first few years after the spill, population estimates for harlequin ducks in oiled areas were less than expected when compared with pre- to postspill trends for unoiled areas (Klosewski and Laing 1994). Similar comparisons have not been conducted since 1991 but McKnight et al. (2006) suggest that harlequin duck populations in oiled areas have remained stable since the spill. Note: Depending upon the additional sampling effort required by new survey protocols we may remove this element of the survey in 2009.

C. Data Analysis and Statistical Methods

Pilot Study

The pilot study will provide estimates of within-year transect variability. The amount of variability reduction at the transect level will determine the increase of power to detect trends at smaller spatial scales. In addition, we can assess if there is more variability than would be expected under the Poisson model assumption and adjust the model accordingly. Transect level variability estimates are also necessary for any new sampling protocol optimization should we wish to start making inferences at smaller spatial scales. These will be incorporated into our Population Monitoring survey (Rosenberg et al. 2005).

Population Monitoring Surveys

Population composition and annual changes in density will be compared to test whether harlequin duck populations in oiled and unoiled areas are exhibiting similar growth trends or the oiled (injured) population is exhibiting a different direction or rate of change at various spatial scales. We will continue to test for differences in population age and sex structure between treatments (see Rosenberg et al. 2005) and at various spatial scales within the oiled treatment. The proportion of first-year males to total males will be used as a measure of past reproductive success. Surveys will be used to detect changes in abundance and compare the direction and rate of change between years for the four survey areas and two treatments. Data from winter surveys in 1997, 2000–2002, 2004–5, and 2007–8 will be incorporated into the analysis.

Survey Coverage

Shoreline length (km) of transects will be calculated from the Alaska Department of Natural Resources PWS_ESI ARC/INFO GIS database. Shoreline length of small islands not included in the PWS_ESI ARC/INFO GIS database was calculated using the U.S. Forest Service CNFSHORE ARC/INFO GIS database. Shoreline length (km) of transects from the 1972-1973 surveys was provided by the USFWS.

Sex and Age Structure

We will use a generalized logit model (natural logarithm of ratios) (Agresti 1990) to test for annual differences between treatments, regions, and oil exposure for various sex and age ratios (Rosenberg et al. 2005). Model fit is assessed using AIC and a backward elimination process. At each step a reduced model is used to test for significant year, area, or treatment effect (Agresti 1990). Such a criterion allows for optimal fitting of the data without over-parameterizing the model. The SAS model used the GLIMMIX Procedure with a binomial distribution and a logit link function.

Proc GLIMMIX allows us to create a more complex covariance structure that accounts for the correlation found in measuring the same transects over multiple years. This reduces the occurrence of Type I errors since the variance is more appropriately modeled and not

underestimated. We will add an extra variance component to the current Proc GLIMMIX code to estimate the transect measurement variability.

The full model (Rosenberg et al. 2005) will be modified as follows (using the sex ratio as an example):

$$\ln\left(\frac{m_{1jk}}{m_{2jk}}\right) = \alpha + \beta * year_j + \tau_k + \gamma_k * year_j + \tau_l + \gamma_l * year_j$$

Where *m* is the expected number of birds counted;

sex is indexed by number (1 = male, 2 = female);

j indexes year (1 = 1997, 2 = 2000, 3 = 2001, 4 = 2002, 5 = 2004, 6 = 2005);

k indexes oil exposure (1 = heavily oiled, 1 = medium oiled, 1 = lightly oiled, 4 = unoiled); and

l indexes geographic regions (EPWS1-3, MONT, SWPWS, WPWS1-4).

Trend Analysis

Transect observations will be modeled as Poisson counts weighted by transect length (Rosenberg et al. 2005). We will standardize all counts of birds to linear densities (birds/km of shoreline surveyed) to facilitate comparisons in change in densities among model indices. We will use Proc GLIMMIX with a Poisson distribution and identity link function.

Because the sampling scheme was not appropriate for comparing overall measures of abundance among regions we will model the two treatments separately, including estimating difference variance components for each treatment. As in the ratio analyses, proc GLIMMIX also allows us to account for the correlation found in measuring the same transects over multiple years. We will add an extra variance component to the current Proc GLIMMIX code to estimate the transect measurement variability.

The full model (Rosenberg et al. 2005) will be modified as follows:

$$n_{jkl} = \alpha_k + \beta_k * year_j + \tau_k + \gamma_k * year_j + \tau_l + \gamma_l * year_{j\,j}$$

Where *n* is the expected number of birds counted;

j indexes year (1 = 1997, 2 = 2000, 3 = 2001, 4 = 2002, 5 = 2004, 6 = 2005);

k indexes oil exposure (1 = heavily oiled, 1 = medium oiled, 1 = lightly oiled, 4 = unoiled); and

l indexes geographic regions (EPWS1-3, MONT, SWPWS, WPWS1-4).

Historical Comparisons (if continued)

We will partition the historical transects surveyed by Dwyer et al. (1976) by treatment (oiled or unoiled). Within treatments, transects will be stratified according to harlequin duck habitat quality and oiling history. All transects within the oiled treatment that contained harlequin ducks in 1972 and 1973 and were lightly to heavily oiled by the spill (Alaska Department of

Environmental Conservation) will be resurveyed and transects from the unoiled regions will be randomly selected while keeping the proportion of transects within each strata similar to transects in the oiled region. In 2007 and 2008 we surveyed approximately 20 transects per treatment. These will be resurveyed in 2009. Some of these transects are subsets of our existing survey and do not require additional survey effort.

D. Description of Study Area

The proposed project will be conducted in the oil spill area of western and southwestern Prince William Sound and unoiled eastern PWS between Valdez and Cordova, western Montague Island and northern PWS from Valdez Arm to Passage Canal.

March surveys will repeat transects surveyed in /407 Harlequin Duck Recovery Monitoring (Rosenberg et al. 2006). Transects in the spill area will be located on Knight Island, Applegate Island, Culross Island, Foul Bay, Falls Bay, Crafton Island, Chenega Island, Green Island, Naked Island, and Bainbridge, Evans, Danger and Latouche islands. Surveys in unoiled areas will include portions of Hinchinbrook Island, Simpson Bay, Sheep Bay, Port Gravina, Landlocked Bay, Bligh and Busby islands, Galena Bay and Valdez Arm, and Montague Island. Additional transects necessary for historical comparisons were selected from areas throughout PWS.

E. Coordination and Collaboration with Other Efforts

We propose to coordinate and collaborate in either the planning and/or results of this project with several ongoing and proposed *Exxon Valdez* Oil spill Trustee council projects including the following: 1) Quantifying Temporal Variation in Harlequin Duck Exposure to Exxon Valdez Oil, Dan Esler, Project 0777; 2) Oil Exposure in Nearshore Vertebrate Predators, Brenda Ballachey, project 0774; 3) Lingering Oil and Predators: Pathways of Exposure and Population Status, Stanley Rice, project /0620; 4) Surveys to Monitor Marine Bird Abundance in PWS, project 0751, David Irons; 5) Evaluating Harlequin Duck Population Recovery, project 0816, Dan Esler; and a new proposed project 6) Evaluating Injury to Harlequin Ducks (*Histrionicus histrionicus*) Caused by Sublethal Hydrocarbon Exposure in Prince William Sound Using Species-specific Cell Lines, Tuula Hollmen and Katherine Springman.

This work was also heavily utilized by Integral Consulting, Inc., for Assessment of Lingering Oil and Resource Injuries from the *Exxon Valdez* Oil Spill, project 0776 and Information Synthesis and Recovery Recommendations for Resources and Services Injured by EVOS, project 0783 and information will be incorporated in any future synthesis efforts.

ADF&G personnel will conduct all data collection and analysis. Winter surveys and contracts for vessel support for winter surveys will be coordinated with related EVOS projects.

This project will be integrated with ongoing studies and findings of past studies including project 407 Harlequin Duck Population Dynamics: Measuring Recovery from the Exxon Valdez Oil Spill. Information exchange has been ongoing with several marine bird and mammal studies.

III. SCHEDULE

A. Project Milestones

Objective 1. Conduct Pilot Study to measure transect variability. To be met by March 2009.

Objective 2. Develop new sampling protocol based on results of Pilot Study. To be met by March 2009.

Objective 3. Compare population structure between treatments using new sampling protocol. To be met by April 2009.

Objective 2. Compare annual changes in density between treatments using new sampling protocol. To be met by April 2009.

Objective 3. Compare annual changes in density and population structure *within* oiled and unoiled treatments at smaller spatial scales. To be met by April 2009.

Objective 4. Compare changes in densities of harlequin ducks between winters of 1972 and 1973 with winter 2009 surveys for both oiled and unoiled areas. To be met by April 2009. This objective may be eliminated depending upon time constraints (see text).

Objective 5. Add to our knowledge of harlequin duck life history and provide long-term data set for population modeling. To be met by October 2009 (report) and provide Population Modeler with data as needed.

Objective 6. Monitor population change in other sea ducks within our survey area, relative to harlequin duck population changes. To be met by March 2009.

This is proposed as a possible multi-year monitoring program designed to assess the recovery of an injured species. Each project objective will be assessed annually for oiled and unoiled areas then compared with each other and with data collected in subsequent years.

B. Measurable Project Tasks

FY 09, 1st quarter (October 1, 2008-December 31, 2008)
- Interagency coordination.
- Plan logistics and personnel for second phase of Pilot Study and winter surveys.
- Contract for vessel support.
- Refine protocols for Pilot Study

FY 09, 2nd quarter (January 1, 2009-March 31, 2009)
- Attend Marine Science Symposium.
- Hire seasonal technicians.
- Prepare field equipment.

Finalize field logistics.
Conduct second phase of Pilot Study.
Analyze data and develop new survey protocols.
Conduct winter surveys in PWS.

FY 09, 3rd quarter (April 1, 2009-June 30, 2009)
Create databases, GIS.
Begin analysis of field data and report preparation.
Maintain equipment.

FY 09, 4th quarter (July 1, 2009-September 30, 2009)
Finish analyses and final report/manuscript preparation.

V. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

A Traditional Ecological Knowledge report was prepared as part of EVOS Restoration Project 427 Harlequin Duck Recovery Monitoring (Rosenberg and Petrula 1998). Results of this project have been presented in Tatitlek and Chenega Bay. As we have done in the past we will coordinate when appropriate with the villages of Tatitlek, Chenega Bay, Cordova, Valdez, and Whittier on our activities and possibilities for community involvement. No funds are being requested for local hire or community involvement. We will solicit bids for contract work from local communities.

B. Resource Management Applications

The Alaska Department of Fish and Game, has a statutory mandate to manage and protect wildlife and their habitats on state and private lands for the benefit of Alaskans. Migratory bird management requires good scientific information to detect population change, prevent habitat degradation, and manage public uses of migratory birds and their habitats. Numbers of several sea duck species are declining throughout much or all of their range including Alaskan breeding populations (Goudie et al 1994, Hodges 1996). The ADF&G Statewide Waterfowl Program is responsible for adopting migratory bird hunting regulations (sport and subsistence) within the Pacific Flyway under the federal framework, and commenting on permits for mariculture and wetland, development within the nearshore environment, adjacent commercial and recreational activities, and oil spill contingency plans. This study will provide ADF&G with information to improve its management capabilities. Contact Tom Rothe or Dan Rosenberg, ADF&G.

V. PUBLICATIONS AND REPORTS

A final report will be presented by March 2010. Publications will be prepared for peer-review journals in lieu of final report when possible and will depend upon the duration of the project.

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2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2007 - September 30, 2008

Budget Category:	Authorized FY 2008	Proposed FY 2009	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$84.6	$101.0						
Travel	$1.0	$0.6						
Contractual	$48.8	$72.4						
Commodities	$5.1	$8.1						
Equipment	$2.4	$0.0						
Subtotal	$141.9	$182.1						
General Administration	$16.1	$16.4						
Project Total	$158.0	$198.5						
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
FY08-FY09 Interim budget. Reflects need for additional survey time.

FY09

Prepared: Sept 4, 2008

Project Number: 759
Project Title: Harlequin Duck Population Dynamics in PWS
Agency: Alaska Department of Fish and Game

2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2007 - September 30, 2008

Personnel Costs:		GS/Range/	Months	Monthly		
Name	Position Description	Step	Budgeted	Costs	Overtime	
D. Rosenberg	WBIII, Principal Investigator	18M	3.2	9.1	9.0	
Mike Petrula	WBII, survey and logistical support	16 J	1.5	7.5	7.1	
Doug Hill	WB1 survey and logistical support	14F	3.5	6.1	5.3	
Aaron Christ	Biometrician data analysis	20C	1.5	8.5	5.0	
	Subtotal		9.7	31.2	26.4	
					Personnel Total	

Travel Costs:	Ticket	Round	Total	Daily	
Description	Price	Trips	Days	Per Diem	
Whittier parking, 2 vehicles- 21 days					
Whittier Toll - 2 vehicles and trailers (Ticket Books)					
				Travel Total	

FY09

Prepared: Sept 4, 2008

Project Number: 759
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Agency: Alaska Department of Fish and Game

2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2007 - September 30, 2008

Contractual Costs:	
Description	
Boat and outboard motor repair and maintenance Air charter for field support 4 hrs @ $500/hr Launch fee, Trailer and boat moorage Whittier Vessel support for surveys 32 days @1700/day Field Technician, Survey and Logistical Support	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	
Commodities Costs:	
Description	
Boat fuel 740 gallons @ $4.80/gal Boat supplies- replacement parts, props, fuel lines, fuel filters, water filters, battery, absorbent rags, oil, emergency provisions Field survey supplies- rite-in-rain notebooks/paper, nautical charts, batteries,	
Commodities Total	

FY09

Prepared: Sept 4, 2008

Project Number: 759
Project Title: Harlequin Duck Population Dynamics in PWS
Agency: Alaska Department of Fish and Game

2008 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2007 - September 30, 2008

New Equipment Purchases:	Number of Units	Unit Price	
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage:	Number of Units	
Description		
19 ft.rigid hull inflatable	1	
17 ft. Boston Whaler	1	
10x40 binoculars	4	
Image Stabilized binoculars	2	
Spotting Scopes	2	
Survival Suits	4	
Outboard Motors/various hp	5	
GPS	2	
Marine VHF radios	4	
Trucks	2	
Personal locator beacons	2	
Exposure Suits	4	

FY09

Prepared: Sept 4, 2008

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